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BRYOPHYTES AND THEIR USELFULNESS IN CHARACTERIZATION OF A NATURE CONSERVATION AREA (BÁTORLIGET MIRE RESERVE, NE HUNGARY)

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Bátorliget Mire Reserve is one of the last relics of the mire and woodland area in the Nyírseg region, NE Hungary. It was discovered in 1914 by J.Tuzson. By 1930 only one fourth of the mires and forests had survived the drainage and clearing of the area. From 1938 till 1951 some fragments were unified in a protected area of about 60 hectares. The results of previous zoological and botanical studies were collected in a monograph edited by Székessy (1953). Thorough botanical and zoological research started again recently after almost 40 years of neglect (Mahunka 1991). As a part of this project I studied the bryophyte flora. All my updated results are compared with previous knowledge and some conclusions are drawn about the tendencies of changes and the possible future of this unique area.

The moss flora of Bátorliget (Tab. 1) is much poorer than could be expected from the diversity of vascular flora, which contains quite a lot of montane species. The first three columns following each species were included in the lists in 1953, 1979 and/or 1990, respectively. The next 6 columns show the vegetation units in which the species were found in 1990 (cf. Standovár & Tóth 1989). A: Sandy Pedunculate Oak - Silver Lime Forest; B: Oak - Elm - Ash Gallery Forest; C: Birch Swamp; D: Wet Meadows; E: Marsh Mire Willow Swamp. Here the last category F means buildings and concrete fence poles. The last 4 columns contain life strategy (Str) an T, W, R characteristics.

Several non-floristic characteristics of species are used for the interpretation: T (temperature optimum), W (humidity optimum), and R (acidity optimum) indicator values show the ecological requirements of species. These values are used after Orbán (1983), who accepted Zólyomi's (1967) system for vascular plants: T - thermophobic (1) to thermophilic (7) and indifferent (0); W - xerophilous (1) to hygrophilous (11) and indifferent (0); R - acidophilic (1) to basophilic (5) and indifferent (0). Life strategy categories (Str) published by Orbán (1983) are also used here: C - colonist; AS - annual shuttle; LS - long-lived shuttle; P - perennial. His system is based on the work by During (1979).

Each species was described in terms of one state of T, W, R and Str character sets. Bryophyte flora is characterized by relative frequencies of these four character states. Considering the bryophyte flora of different times of recording and vegetation units in the light of non-floristic descriptors (Figs. 1-8).

T - temperature optimum

As Figs. 1 and 2 show, neither the vegetation types nor the subsequent lists have significantly different frequency distributions of T character states. On the other hand, the spectrum is quite different from that of the Hungarian bryophyte flora.

W - humidity optimum

The distribution of W character states (Fig. 3) is more similar to the average of the Hungarian flora than the T distribution is. The proportion of species with high water requirement (W > 6) has decreased to some extent whereas the importance

Tab. 1 The first three columns following each species name show whether the species was included in the lists in 1953, 1979 and/or 1990, respectively. The next 6 columns show the vegetation units in which the species were found in 1990 (cf. Standovár & Tóth 1989). A: Sandy Pedunculate Oak - Silver Lime Forest; B: Oak - Elm - Ash Gallery Forest; C: Birch Swamp; D: Wet Meadows; E: Marsh, Mire, Willow Swamp. Here the last category F means buildings and concrete fence poles. The last 4 columns contain life strategy (Str) and T, W, R characteristics.

	BRYOPHYTA	53	79	90	A B C D E F	Str	T	W	R
	HEPATICOPSIDA								
	Marchantiaceae								
1	Marchantia polymorpha	+	-	+	- - - - - F	C	8	8	0
	Ricciaceae								
2	Riccia fluitans	-	-	+	- - - - E -	AS	8	11	3
3	Riccia cavernosa	-	-	+	- - - - E -	AS	5	7	0
4	Ricciocarpos natans	+	-	+	- - - - E -	AS	8	11	0
	Metzgeriaceae								
5	Metzgeria furcata	-	-	+	- B - - - -	C	5	5	3
	Aneuraceae								
6	Aneura pinguis	-	-	+	- B - - - -	C	5	9	5
	Lophocoleaceae								
7	Lophocolea heterophylla	-	-	+	A B C D E -	P	5	4	2
	Radulaceae								
8	Radula complanata	+	+	+	- B C - - -	LS	5	4	0
	Porellaceae								
9	Porella platyphylla	+	+	+	- B - - E -	LS	5	4	0
	Jubulaceae								
10	Frullania dilatata	+	+	+	A B C - - -	C	5	3	0
	SPHAGNOPSIDA								
	Sphagnaceae								
11	Sphagnum recurvum	-	-	+	- - - D - -	P	5	11	1
	POLYTRICHOPSIDA								
	Polytrichaceae								
12	Atrichum undulatum	+	+	+	A B - - - -	P	5	5	0
13	Polytrichastrum formosum	-	-	+	A - - - - -	P	5	5	2
14	Polytrichum juniperinum	+	+	+	A - - - - -	P	6	3	2
	BRYOPSIDA								
	Ditrichaceae								
15	Ceratodon purpureus	+	-	+	A - - - - F	C	8	1	0
	Dicranaceae								
16	Dicranella heteromalla	-	-	+	- - C - - -	C	4	1	1
17	Dicranum scoparium	-	-	+	- B C - E -	P	4	4	1
18	Dicranum viride	-	-	+	- - C - E -	P	4	1	1
19	Orthodicranum montanum	-	-	+	- B C - - -	C	4	1	1
	Fissidentaceae								
20	Fissidens taxifolius	-	+	-		C	5	3	0
	Encalyptaceae								
21	Encalypta streptocarpa	+	-	-		C	5	2	5
	Trichostomaceae								
22	Barbula unguiculata	+	+	-		C	6	2	5
	Pottiaceae								
23	Pottia davalliana	-	-	+	- - - D - -	AS	6	4	5
24	Tortula ruralis	+	-	-		C	5	1	5
25	Tortula subulata	+	-	-		C	5	4	0
	Grimmiaceae								
26	Grimmia pulvinata	-	-	+	- - - - - F	C	5	4	3
	Funariaceae								
27	Funaria hygrometrica	+	-	-		F	8	3	0
28	Physcomitrium pyriforme	+	-	+	- B - D - -	AS	5	4	0
	Bryaceae								
29	Bryum argenteum	+	-	+	- - - - - F	C	5	3	5
30	Bryum flaccidum	-	+	+	A B C - - -	C	5	5	0
31	Bryum pseudotriquetrum	+	-	-		P	5	9	5
32	Pohlia nutans	+	-	+	A - - - - -	C	5	5	2
33	Rhodobryum ontariense	+	-	-		P	5	3	0
	Mniaceae								
34	Plagiomnium affine	+	+	+	- - - D - -	LS	4	5	2
35	Plagiomnium cuspidatum	+	-	+	- B C D - -	LS	5	5	0
36	Plagiomnium elatum	+	+	-		LS	4	10	0
37	Plagiomnium rostratum	-	+	+	- - - D - -	LS	5	5	0
38	Plagiomnium undulatum	+	+	+	- B - D - -	LS	3	5	0
	Orthotrichaceae								
39	Orthotrichum affine	+	-	+	A - [illegible]	C	5	2	0
40	Orthotrichum anomalum	-	-	+	- - [illegible]	C	5	2	0
41	Orthotrichum diaphanum	-	-	+	- - [illegible]	C	5	2	5
42	Orthotrichum lyellii	+	-	-		LS	5	3	0
43	Orthotrichum pallens	+	-	+	[illegible]	C	5	2	0
44	Orthotrichum pumilum	+	-	+	[illegible]	C	5	2	0
45	Orthotrichum speciosum	+	+	+	[illegible]	LS	5	2	0
46	Orthotrichum stramineum	+	-	+		C	5	2	0
47	Orthotrichum striatum	+	-	-		LS	5	2	0
48	Orthotrichum tenellum	-	+	+	- B - - - -	C	5	2	0
49	Ulota crispa	+	-	-		LS	5	5	0
	Leucodontaceae								
50	Leucodon sciuroides	+	-	+	- B - - - -	LS	6	2	0
	Fontinalaceae								
51	Fontinalis antipyretica	+	-	-		P	5	11	4
	Climaciaceae								
52	Climacium dendroides	+	-	+	- - - - E -	P	5	5	2
	Leskeaceae								
53	Leskea polycarpa	+	+	+	- B - - - -	P	5	5	5
54	Leskeella nervosa	-	-	+	- B - - - F	P	5	5	0
	Thuidiaceae								
55	Abietinella abietina	+	-	+	- - - D - -	P	5	2	5
56	Anomodon attenuatus	+	-	+	- B - - - -	P	5	5	5
57	Anomodon longifolius	+	-	-		P	5	5	5
58	Anomodon viticulosus	+	+	+	- B - - - -	P	5	5	5
59	Thuidium recognitum	+	-	+	- - - D - -	P	5	5	0
	Amblystegiaceae								
60	Amblystegium juratzkanum	+	-	-		P	5	6	0
61	Amblystegium serpens	+	-	+	- B C - - -	P	5	4	0
62	Amblystegium varium	+	+	+	- B - - E F	P	5	6	0
63	Calliergonella cuspidata	+	+	+	- B - D - -	P	4	9	0
64	Drepanocladus aduncus	+	+	+	- B - D E -	P	0	11	0
65	Leptodictyum kochii	+	+	+	- - - - E -	P	5	9	0
66	Leptodictyum riparium	+	+	+	- B - D E -	P	5	10	0
	Brachytheciaceae								
67	Brachythecium mildeanum	+	-	-		P	5	7	0
68	Brachythecium rutabulum	+	+	+	- B - D E -	P	5	6	0
69	Brachythecium salebrosum	+	+	+	A B - D - -	P	5	5	0
70	Brachythecium velutinum	+	+	+	[illegible]	P	5	5	0
71	Camptothecium lutescens	-	-	+	[illegible]	P	5	1	5
72	Eurhynchium striatum	-	-	+	[illegible]	P	5	5	3
73	Homalothecium sericeum	-	-	+	[illegible]	P	5	2	5
74	Oxyrrhynchium swartzii	+	+	+	- B C D E -	P	5	5	0
75	Pseudoscleropodium purum	-	-	+	- - - D - -	P	5	5	3
	Entodontaceae								
76	Pterygynandrum filiforme	-	-	+	A - - - - -	P	5	5	2
	Plagiotheciaceae								
77	Plagiothecium succulentum	-	-	+	- B - - - -	P	5	5	1
	Hypnaceae								
78	Hypnum cupressiforme	+	+	+	A B C D E F	P	0	3	0
79	Platygyrium repens	-	-	+	- B C - E -	C	5	5	0
80	Pylaisia polyantha	+	+	+	A B C - E F	P	5	4	0
	Hylocomiaceae								
81	Hylocomium splendens	+	-	-		P	4	5	2
82	Pleurozium schreberi	+	-	-		P	4	5	2

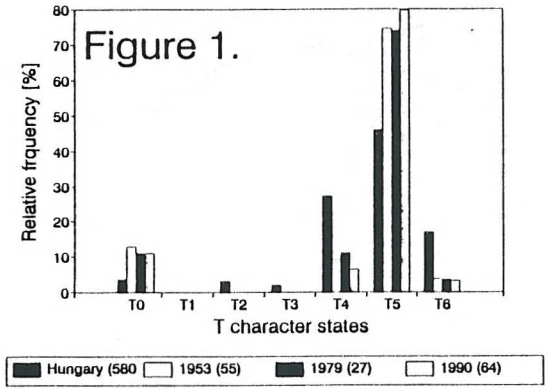

Fig. 1. The average distribution of T character states of bryophytes in Hungary and in different years at Bátorliget. In brackets the number of species examined is given

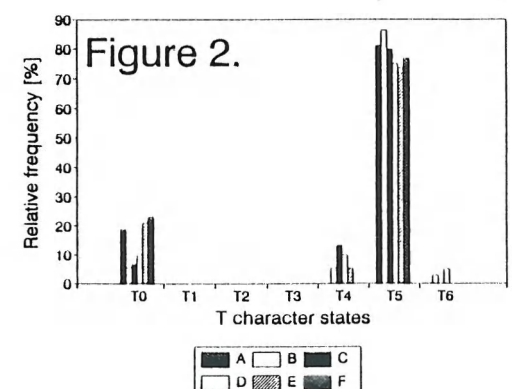

Fig. 2. The average distribution of T character states of bryophytes in the different vegetation types of Bátorliget in 1990. Capital letters are used as in Table 1

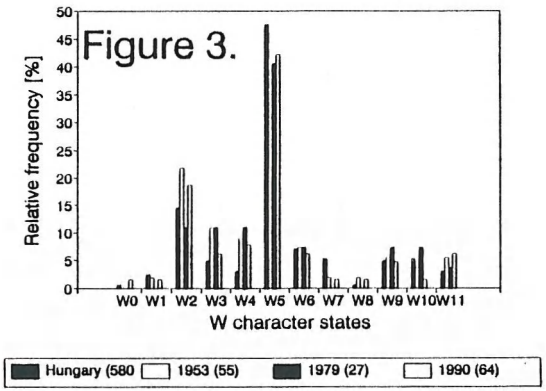

Fig. 3. The average distribution of W character states of bryophytes in Hungary and in different years at Bátorliget. In brackets the number of species examined is given

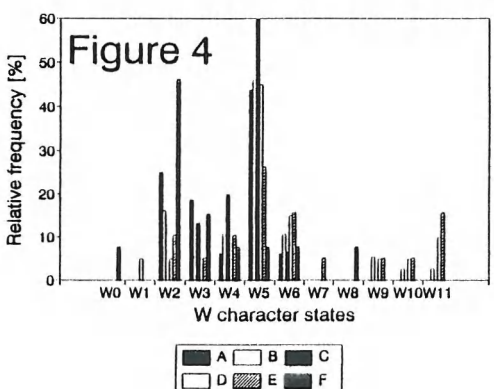

Fig. 4. The average distribution of W character states of bryophytes in the different vegetation types of Bátorliget in 1990. Capital letters are used as in Table 1

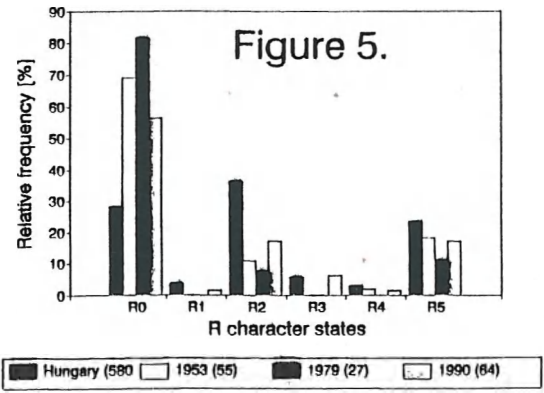

Fig. 5. The average distribution of R character states of bryophytes in Hungary and in different years at Bátorliget. In brackets the number of species examined is given

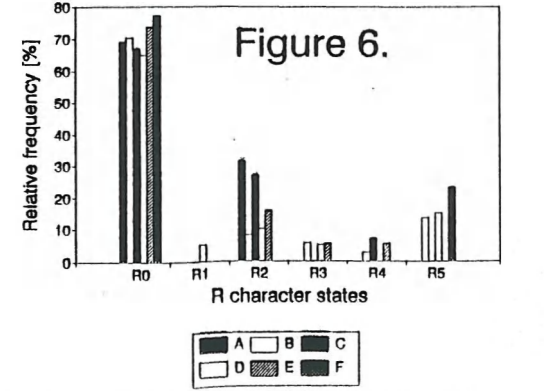

Fig. 6. The average distribution of R character states of bryophytes in the different vegetation types of Bátorliget in 1990. Capital letters are used as in Table 1

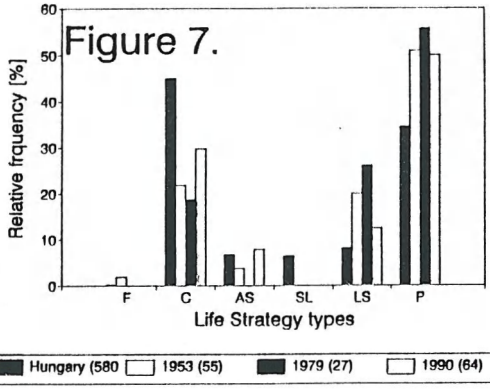

Fig. 7. The average distribution of life Strategy types [Str] of bryophytes in Hungary and in different years at Bátorliget. In brackets the number of species examined is given

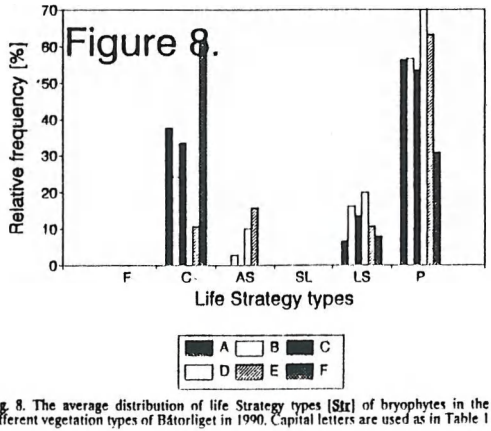

Fig. 8. The average distribution of life Strategy types [Str] of bryophytes in the different vegetation types of Bátorliget in 1990. Capital letters are used as in Table 1

of species with W = 5-6 has increased. These can indicate the overall drying of the area. On the other hand, the number of xerophilous species (W = 2-4) has decreased, which can be the result of the fact that in 1953 the species of the dry sandy grassland near Bátorliget were also included. The distribution of W character states in the different vegetation types (Fig. 4) is in good agreement with the expected picture.

R - acidity optimum

Different years have similar spectra (Fig. 5), but some of them differ considerably from the characteristic R distribution of the Hungarian bryophyte flora. The high percentage of indifferent (R = 0) species is surprising. The relatively high percentage of acidophilic (R = 1-2) species in 1990 is due to the 7-8 new strongly acidophilic records from the area (*Sphagnum recurvum, Lophocolea heterophylla, Polytrichastrum formosum,* species of *Dicranaceae*, etc.).

R character state distributions (Fig. 6) show that acidophilic species occur in sandy pedunculate oak forests, whereas most basophilic species grow on buildings and concrete fence poles. Other vegetation types provide more diverse habitats (e.g. acidic bark of trees versus neutral or base rich soils in the same vegetation type).

Str - life strategies

Fig. 7 show the distribution of different life strategy forms (Str). Colonist [C] and annual shuttle [AS] species are much less important at Bátorliget than in the Hungarian bryophyte flora. Colonist [C] species of pioneer character have small, easily distributed spores, intensive vegetative and generative reproduction, and they usually indicate degradation. Annual shuttle [AS] species regenerate mostly by spores and are also short-lived, occuring in environments where favorable and unfavorable circumstances change periodically (arable fields, sites with temporal flooding, etc.). Adverse periods are survived by species with big and long-fertile spores, like *Physcomitrium* and *Riccia* species.

The proportion of long-lived shuttle [LS] and perennial [P] species is considerably high, which indicates the "goodness" of the area. Long-lived shuttle [LS] species are often epiphytic (e.g *Orthotrichum, Leucodon* spp.) perennials, that reproduce both vegetatively and by big spores, and they indicate stable habitats. Perennial [P] species are similar, but with less effective reproduction. They mostly inhabit mires, marshes, wet meadows and forest soils (e.g. *Sphagnum, Drepanocladus, Brachythecium* spp.).

It is noticeable that by 1990 the relative importance of both C and AS species had increased. Simultaneously LS species have decreased. The proportion of P species has not changed. These shifts indicate that the level of degradation has increased and/or the periodical change of favorable and unfavorable circumstances is now expressed. This can be connected with the overall drying, with the intensive organic matter accumulation in mires and with disturbances caused by heavy mowing machines and wild boars in the wet meadows.

The comparison of Str spectra of different vegetation types (Fig. 8) shows that most of the occurrences of C species are attributable to human activities. Their appearance in different forest types is due to epiphytic species that live on the trunks of the trees. AS species occur at regularly changing aquatic (*Riccia* and *Ricciocarpus* spp.) or disturbed sites (*Pottia* and *Physcomitrium* ssp.)

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